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Application of Polyclonal Planting System of Cocoa (*Theobroma cacao L.*) By Side Grafting Technology in South Sulawesi-Indonesia

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Abstract: ***Most of the farmers in the Cocoa (Theobroma cacao L.) production center in South Sulawesi use clonal planting materials to rehabilitate old plants with side grafting techniques. Generally farmers use superior planting materials with high productivity and yield quality, and have resistance to major pests and diseases and to increase cocoa production, the farmers apply polyclonal cacao planting. The aim of this research were to know the implementation and planting effect of cocoa planted in polyclonal. The location of the research was determined by purposive sampling, in Paroto Village, Lilirilau Sub district, Soppeng District. The research data was obtained based on observations and interviews of cocoa farmers about 30 farmers. The results showed that about 70% of farmers apply biclonal planting system or use 2 clones, about 16.67% farmers apply polyclonal planting system using 3 clones and about 13.33% of other farmers using 4 clones. The production obtained from the three planting systems were 767,11kg / ha, 1009, 44kg / ha and 1698kg /ha, respectively. The cocoa clones used for planting materials were S1, S2, MCC 02 and THR.***

Keywords: Cocoa, Side Grafting, Polyclonal

1. Introduction

Cocoa production generally declines rapidly after the age of 25 years [1], so the cocoa plants at that age needs to be rehabilitated. Currently side grafting technology the main alternative to the rehabilitation of cocoa plants, especially in South Sulawesi-Indonesia using cocoa clones. Clonalization with a side grafting system can use superior local clones that have adapted to the local environment.

Cocoa plants are mostly cross-pollinated and incompatibly self-pollinating plants [2], this is due to the nature of self-incompatibility. According to [3] Self-incompability is an event in which normal pollen and pistil failed to conceive on their own crosses.

Monoclonal gardens for higher production should be refined to polyclonal by side-grafting technology. It is better to use polyclonal superior clones with several clones that are arranged neatly and intermittently. This will help improve the fertilization and growth of young fruit, with respect to the compatibility of cocoa plants. According to [4] Polyclonal planting system can increase the diversity of results so as to achieve maximum production.

To improve the production and quality of cocoa beans, especially in the plantation, it is necessary for plant material in the form of superior varieties / clones that have high yield potential, high quality of beans, more resistant to PBK pest attack, and fruiting fruit pathogens caused by *Phytophthora palmivora* and VSD (*Oncobasidium theobromae*) [5]. The criteria for cocoa clones were yield of> 3 ton / ha / year, yield quality according to the demand of the manufacturer, which has a weight of more than 1 gram of dry beans, seed fat content of more than 55% and seeds less than 12%. Based on the description above, this study aims to describe the application of polyclonal plant system technology in cocoa plants using superior clones.

2. Methodology

This research was conducted in Paroto Village, Lilirilau District, Soppeng Sub district, South Sulawesi Province, Indonesia. The location was geographically located at 0^{o} 6' 0"- 4^{0} 32' 0" South Latitude and 119^{o} 4.2 '18 "- 120^{o} 06' 13" East Longitude. The location of the survey located at a height of 30 meters from sea level with an average temperature of 30-32^{o}C, the soil type is alluvial with a pH ranging from 6-7.

The location of the research was determined purposively or purposive sampling based on the consideration that the location one of cocoa development area which has been getting guidance and assistance related to cocoa cultivation technique. The data source about 30 respondents' farmers who members of the Setia Makmur Farmer Group with consideration as an actively guided farmer group in the research area. Data analysis used is descriptive analysis to describe observation result that is in the form of tables and diagrams.

3. Results and Discussion

In relation to the application and use of clonalization technology, the characteristics of farmers in the research area become factors that will be very influential. The characteristics of existing cocoa farmers can be seen in table 1 below.

Table 1: The Characteristics of Respondent Farmers in South Sulawesi, Indonesia

Characteristics	Average	Percentage (%)
Age	30 – 45 years	51.00
Education	Graduated elementary school	50.70
Dependents	1 – 3 people	50.10
Farming Experience	> 10 years	80.10

Sources: Primary data was analyzed.

Based on the above data it can be seen that the average farmers of respondents (51%) are still in the range of productive age (30-45 years) with good working experience, about 80.10% have experienced above 10 years in cocoa farming. These conditions become very important related to the adoption of technology, both related to clonalization technology and side grafting techniques applied. Where the rate of adoption for the better with the experience and ability to work are owned by farmers. The same thing was reported by [6] who in his study found that the age and experience of farming very significantly influence the decision of farmers in adopting side grafting technology in Sigi Regency, Indonesia. Survey of the use of clones in the field illustrates the difference in the use of superior clones in farmers as shown in Figure 1 below;

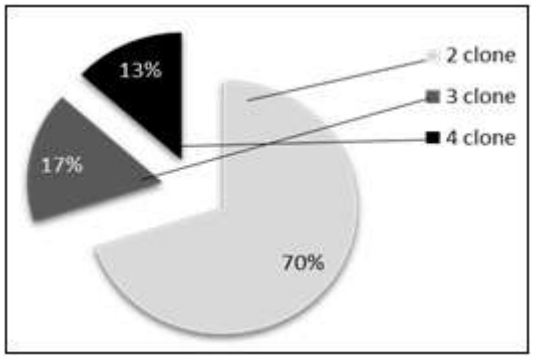

Figure 1: Distribution of farmers by use of clones of cocoa in the Sub district Lilirilau, Soppeng.

Figure 1 it can be seen that the majority of respondents about 70%, cocoa farmers in the study site using two clones on the rehabilitation of the cocoa plant is being introduced through side-grafting techniques, as much as 16.67% of them use the three clones and the rest, about 13.33% using four clones. Based on the identification of clones used by farmers it is known that the clones used in the farmers are clones of hope, namely S1, S2, MCC 02 and THR. The characteristics of these clones are shown in Table 2.

Table 2: The Characteristics of Cocoa Clones used by Farmers in South Sulawesi, Indonesia.

Clone	The color of fruit	Number of fruits (fruit / tree)	Dry weight bean (gr)	Result (ton/ha)	Tolerant
S1 (PBC 123)	Red	110	0.76	3.25	POB and VSD
S2 (BR 25)	Red	140	0.98	3.32	PBK and VSD
MCC 01 (M01)	Green	86	1.7	3.1	NA
THR	Green	NA	NA	NA	NA

[7]; [8]; [9]; [10]; [11].

An Analysis of the clones Sulawesi cocoa 1 and Sulawesi 2 has shown good adaptation to the agro-climatic conditions Sulawesi [7] so that its use can be extended to area of cocoa production centers in Sulawesi, which is used by farmers for the rehabilitation of the plant with engineering side grafting [11]. [2] also reported that Sulawesi 1 and Sulawesi 2 clones were the result of participatory breeding in Sulawesi that proved effective in controlling VSD and increasing crop productivity. This may mean that polyclonal cacao planting can reduce the damage and decline in cocoa production that can occur due to pests and diseases. This is because clones of the same type and planted continuously for a long time will lead to decreased plant genetic resilience and diversity. If in one population, there are several different types of clones, there will be a lot of resistance genes, so as to reduce the decline in cocoa production mainly because of disease.

Table 3: The Use of Input (fertilizer per hectare) of Cocoa Farmers based on Cocoa Polyclonal Planting System in South Sulawesi, Indonesia

Planting system	The amount of fertilizer (kg / ha)					
	ZA	KCl (K)	Urea (N)	NPK	Orga-nic	Total
2 clones	98	21	138	200	143	600
3 clones	200	0	80	200	220	700
4 clones	50	0	225	263	325	863

Sources: Primary data was analyzed.

In plant maintenance activities, the use of fertilizer is a key factor in maximizing cocoa production. Reported [12] that effective use of fertilizers in cocoa will help not only to improve yield but also to benefit from profitability, product quality and environmental protection. Here is an overview of the use of fertilizer in several cocoa planting systems conducted in South Sulawesi.

Based on Table 3 can be known the highest amount of fertilizer use in polyclonal planting system using four clones, but more distribution to organic fertilizer followed by the use of compound fertilizer (NPK). According [13] the nutritional needs of plants age > 4 years for nitrogen at 100 kg / ha, phosphorus 80 kg / ha, potassium 100 kg / ha and Magnesium 24 kg / ha. The result production in various polyclonal cropping systems shows different results as shown in Figure 2 below.

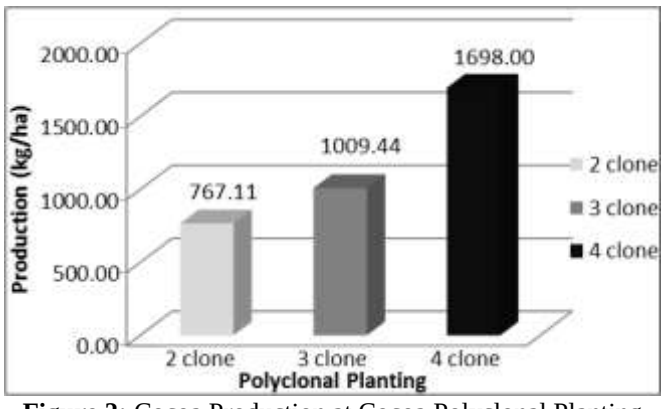

Figure 2: Cocoa Production at Cocoa Polyclonal Planting System in South Sulawesi, Indonesia.

Based on the observation and production analysis, it can be seen that the highest production is achieved on four polyclonal clone system compared to three clones and two clones. Production of each is 1698 kg, 1009 kg and 767 kg. This condition cannot be separated from the process of pollination between clones that can maximize the formation of the fruits of superior clones that can increase the value of fruit and cocoa production. The amount of revenue obtained ranging from IDR 23 million to IDR 50 million depending on the polyclonal system used, the value of each planting system shown in Figure 3.

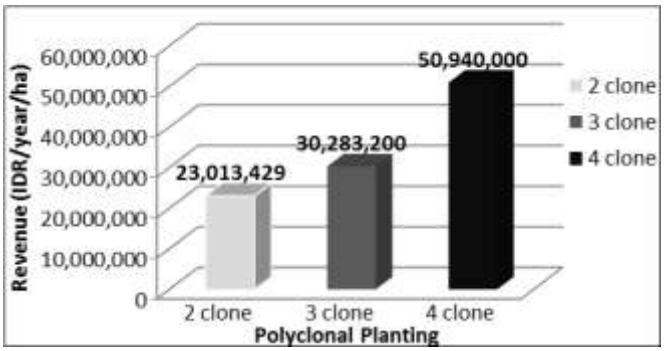

Figure 3: The Farmers' Income at the Cocoa Polyclonal Planting System in South Sulawesi, Indonesia.

The farmer's income per year per hectare in each planting system about IDR 50,940.00, IDR 30,283,200 and IDR 23,013,429. The results of previous research reported by [14] production achieved in Soppeng District as the impact of side grafting can reach 1200 kg / ha / year with an income value of IDR 24,000,000.

4. Conclusion

Based on the results obtained can be that the farmer's do 3 polyclonal planting system by utilizing the superior clones MCC 02, S1, S2, and THR. The highest production was achieved in four polyclonal clones compared to three clones and two clones. Production about 1698 kg, 1009 kg and 767 kg. The farmers' income in each planting system about IDR. 50.940.00, IDR. 30.283.200 and IDR. 23.013.429.

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